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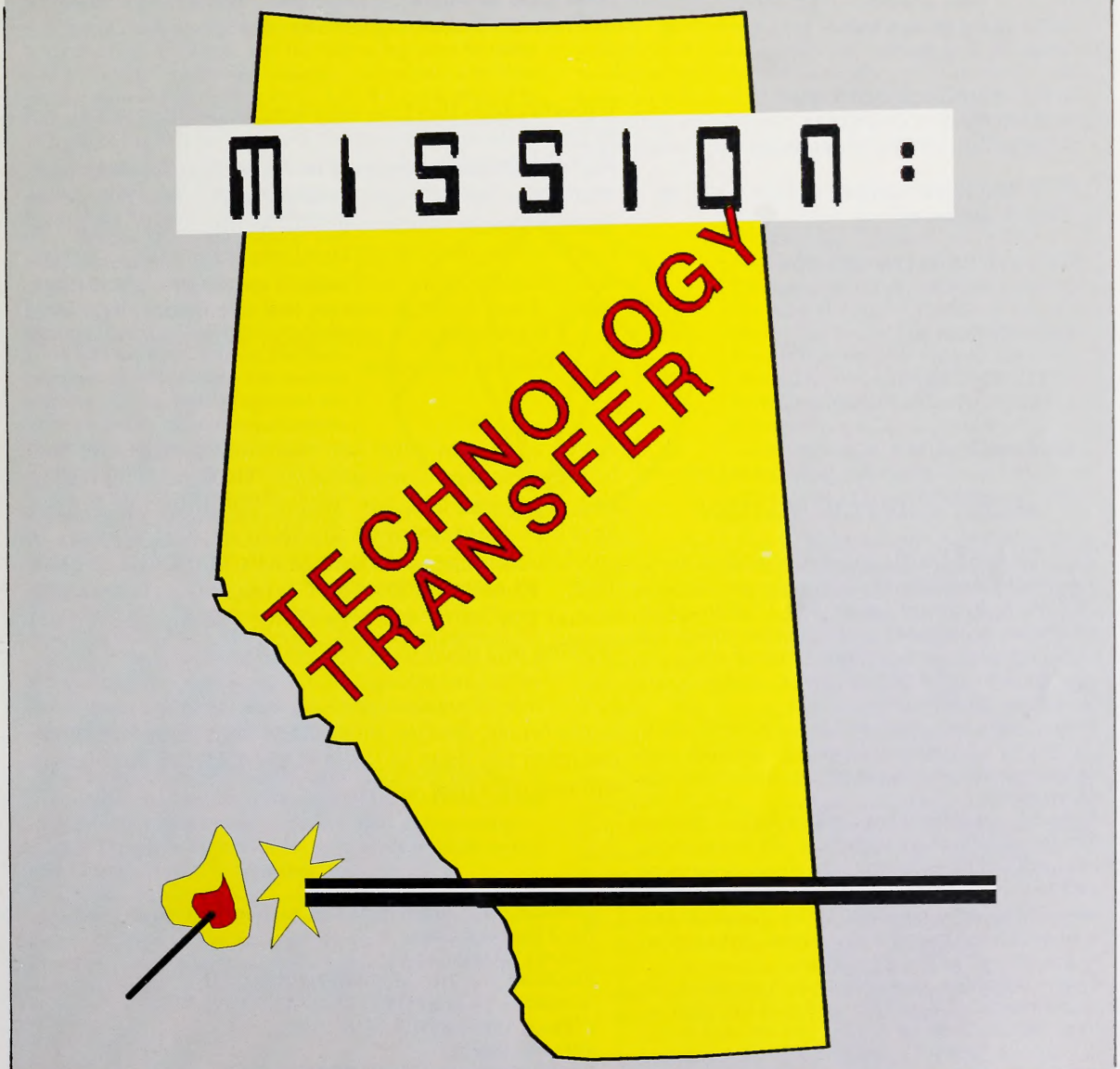
TRANSPORTATION RESEARCH TRANSEARCH

A RESEARCH AND DEVELOPMENT TECHNICAL PUBLICATION



C-LTPP / BRIDGE INVENTORY SYSTEM
MINI TEXTURE METER / C-SHRP / EXPERT SYSTEMS

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ABOUT THIS PUBLICATION

The **TRANSEARCH** quarterly publication is prepared by the Research and Development Branch of Alberta Transportation and Utilities. The publication is dedicated to the effective transfer of transportation and utilities related research information and state-of-the-art technologies throughout the department.

In short news and feature articles, **TRANSEARCH** reports on the most interesting research and technologically significant events concerning the department.

In the interest of providing a vehicle for the effective transfer of technology throughout the department, Research and Development encourages department staff to provide proposals containing unique ideas, innovations or opportunities for research and evaluation which may provide solutions to the various technical needs of the department.

This publication is distributed throughout the department of Alberta Transportation and Utilities. Back issues will be catalogued and retained in the department library. Copies of **TRANSEARCH** are also distributed to other Canadian D.O.T.s as well as Alberta Cities.

EDITOR'S NOTE

In the distribution of the premier issue of **TRANSEARCH** there were a number of copies of the publication that contained a graphical flaw on the front cover. This flaw may have been misconstrued to imply one of many things. One for example, as Alberta's desire to annex the south-eastern corner of British Columbia - NOT SO! However, a nice idea considering that some of Canada's best skiing facilities are located in that area.

Unfortunately this flaw appeared at the proverbial "it's to late to do anything about it stage" so the publication was distributed anyway. For those persons who have retained a flawed copy, hold on to it. You just never know, it may be worth an untold fortune some day in the future in as much as certain flawed monetary coinage minted in the past is worth much more now than it's face value. I still hope, however, that the intrinsic value of the **TRANSEARCH** publication will always be worth more than its face value.

All in all, I was surprised that only one person had brought this flaw to my attention. Because of his daring and outspokenness, Mr. Walter Simpson, the Project Services Technologist in District 4 (Calgary) is proclaimed as the first **TRANSEARCH SEARCH FOR THE FLAWS CONTEST** winner. As a reward, Walter can claim one free coffee (on me, the editor) anytime he's up here in Edmonton.

In the future, the first three individuals that bring to my attention any flaws in the **TRANSEARCH** publication will receive a free coffee.

Comments and suggestions may be submitted to:
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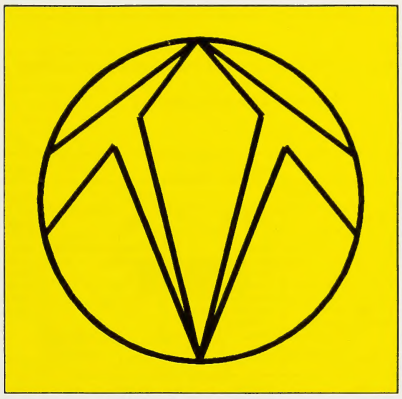
CANADIANA
JUN 28 1989

MISSION: TECHNOLOGY TRANSFER

"Good morning Ray. The figure you are looking at is the symbol for the new Technology Transfer Program which is now under development. Its purpose is to quickly bring to the readers attention that the information he or she is perusing has been prepared by the Technology Transfer Section of the Research and Development Branch of Alberta Transportation and Utilities. The Technology Transfer Program itself is defined as the process by which research findings and development efforts are translated into useful processes, products, and programs. Because of the scarcity of funds available for new construction and maintenance of our highways and the increasing need to safely and efficiently move larger vehicles (and at the same time greater volumes of traffic) we at A.T. & U. are obliged to continue to improve the ways we carry out our operations."

"Your mission, Ray - if you choose to accept it - is to create an organized, efficient program of technology transfer, which will serve as a bridge between research and development and the practical application of new technology to those areas of our organization that have demonstrated a need for it. Your team will have to serve as the communication link among the various sources of new technology and the various areas of our organization which can apply the technology in daily operations. Your team will have to encourage participation by all personnel in the organizational structure to help transmit local needs or locally derived solutions back and forth throughout the organization. You and your TTT (Technology Transfer Team) will have to promote new or improved technologies by means of an active and dynamic interaction between the sources of these technologies and the end users in such a manner that they are appropriately adopted in a cost effective manner and produce tangible improvements to existing technologies currently employed."



"The expression TECHNOLOGY TRANSFER has a profound sound to it, seeming to hail that it is the future saviour of our ever increasingly and complexly growing industry. Do not be fooled - it is much more difficult to put into practice than it is to preach."

"As always, Ray, should you or any of the TTT members be caught sleeping on the job, your secretary will disavow any knowledge of your actions. This daydream will self distruct in five seconds! GOOD LUCK, RAY !!!."

As I was sitting in my office one day, shortly after being assigned this mandate of developing a technology transfer program, wondering how to tackle this challenge, it came to me. This effort will have to be mission orientated. No sooner did that thought cross my mind did I go into a wild daydream frenzy, putting myself into the place of the incomparable Jim Phelps, leader of the IMF (Impossible Mission Force) in the well known TV series MISSION IMPOSSIBLE. "Now how would Jim and his IMF team handle this?" I asked myself. Well the answer is as simple as it is complicated (I better make sure I know what that means before I go on). Simple in the sense that good 'ol Jim and his IMF team would treat this as a mission (what else?). Complicated in a sense that the over all goal or objective would have to be broken down into smaller accomplishable tasks coordinated in such a manner as to meet timely logistical constraints, integrate well with existing organizational procedures, and of course - the budget.

Annnnnny wayyyyyyy, this was not the intention of my first article regarding Technology Transfer (of which I am certain that many more will follow in the future). What I really wanted to do is let the readers (especially A.T. & U. staff) know that technology transfer is more than just another fancy high-tech word floating around in conversation. In fact! - technology transfer is now a real entity in this department. It has physical substance (in the form of R & D staff) and is aimed at providing assistance where needed and at producing (hopefully) tangible results.

This new "MISSION: TECHNOLOGY TRANSFER" will undoubtebly touch upon most areas of the department's physical plant operations sooner or later. Undoubtebly, there may be resistance to change (or to perceived drastic changes). That's alright. Resistance to changes is part of human nature and it is part of the nature of large organizations such as Alberta Transportation and Utilities. The bottom line to this whole initiative is to improve and efficientize (the TTT create new words too) our daily operational tasks. For those who need (or want) these improvements or need assistance in direction towards potential solutions - come talk to us, maybe we'll be able to help. For those who do not want or feel they do not need assistance - don't worry, be happy - our intentions are not to force new technologies upon you just for the sake of it.

By way of a conclusion to this article (which is well overdue by now) I would like to take this opportunity to invite any and all readers within or without A.T. & U. to contact me directly with any ideas, suggestions or needs. The TTT and I pledge to give our best effort in serving you.

RAY FILIPIAK

CANADIAN LONG TERM PAVEMENT PERFORMANCE PROGRAM

A survey of provincial and territorial departments of transportation revealed that predominant interest existed for carrying out research on the performance of rehabilitated pavements. In particular the targeted pavements were:

-asphalt concrete
-granular base course
-ACP scheduled for rehabilitation
-asphalt concrete overlays
-hot mix recycling
-milling

Using this as a basis the C-SHRP Pavements Advisory Committee developed a C-LTPP, with all provinces participating. The major objectives of C-LTPP are:

(i) To evaluate Canadian practice in the rehabilitation of flexible pavements and to subsequently develop improved methodologies and strategies.

(ii) To enhance the applicability in Canada of pavement performance prediction models developed by the United States SHRP.

(iii) To establish common methodologies for long term pavement evaluation, and to provide a national framework for continued pavement research initiatives.

The major study variables being addressed by C-LTPP are:

-traffic loading
-subgrade strength/susceptibility
-moisture availability
-freezing index
-condition prior to rehabilitation

The test site sampling matrix for C-LTPP is shown below.

At each site there will be two adjacent test sections consisting of two different rehabilitation strategies. Should we wish to evaluate other strategies in the Alberta context, these will be placed downstream of the two C-LTPP sections.

An illustrative example of a test site is shown on the opposite page.

Canadian Long Term Pavement Performance (C-LTPP)

Test Site Sampling Matrix

ENVIRONMENT / FREEZING INDEX / SUBGRADE / TRAFFIC		WET			DRY
		LOW		HIGH	HIGH
		FINE	COARSE	FINE	FINE
LOW		Ontario Quebec Nova Scotia PrinceEdward Island New Brunswick British Columbia (3 OL/2 OP) — 1	Ontario Quebec Nova Scotia Newfoundland New Brunswick British Columbia Prince Edward Island (3 OL/1 OP) — 2	Ontario Quebec (2 OL) — 3	Alberta Saskatchewan Manitoba Northwest Territories Yukon (3 OL/2 OP) — 4
HIGH		Ontario Quebec Nova Scotia New Brunswick British Columbia (3 OL/2 OP) — 5	Ontario Quebec Nova Scotia New Brunswick British Columbia Newfoundland (3 OL/1 OP) — 6	Ontario Quebec (2 OL) — 7	Alberta Manitoba Saskatchewan (3 OL/2 OP) — 8
		10 sites	8 sites	2 sites	10 sites
					30 sites

Ontario Quebec Nova Scotia New Brunswick British Columbia (3 OL/2 OP) — 5

- ← cell identification number
- ← those jurisdictions having pavements under these cell conditions
- ← minimum test sites required

* 3 OL = three overlay sites having two test sections each

*2 OP = two other paired test sites having recycled/milled sections

Our minimum contribution to C-LTPP currently stands at three test sites (6 sections):

1 Overlay Site
2 Recycle/Mill Sites

Materials Engineering Branch is currently investigating suitable candidate sections in this year's rehabilitation program. Once established these sections will be monitored for a minimum of 10 years. However, to obtain maximum benefit and confidence in predicting performance, a 15 year monitoring period would be desirable.

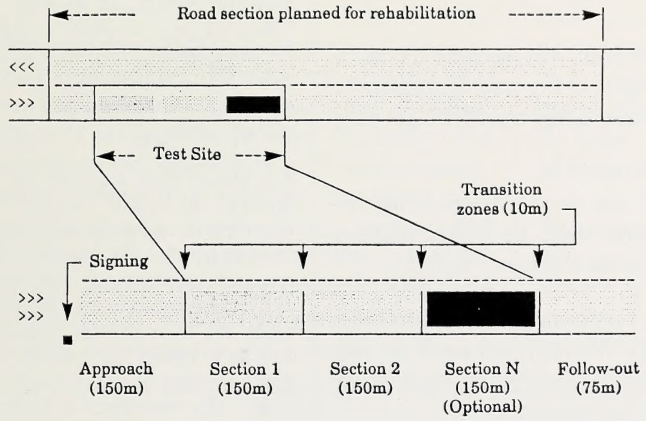
A program of this type of course cannot be achieved without considerable input and effort from all participating agencies. Some of the activities are one time, but some are ongoing throughout the monitoring period.

A breakdown of activities and responsibilities is shown on the opposite page.

As you drive the Alberta highways this summer, keep your eyes peeled for these sections. They, along with test sections (4) in the SHRP LTPP will be clearly marked with signs displaying either C-SHRP or SHRP logos.

JAN KONARZEWSKI

	ACTIVITY	RESPONSIBILITY
One-time Activities	Test Site Identification	Agencies
	Signing and Marking	Agencies
	Materials Sampling	Agencies
	Prior Condition	
	• Distress	Agencies
	• Profile	Agencies/C-SHRP
	• Strength	Agencies/C-SHRP
	Materials Testing	Agencies/C-SHRP
	Site Rehabilitation	Agencies
	Evaluation of Spring Factor	Agencies
	Historical Data Collection	Agencies
On-going/Annual Activities	Traffic Monitoring	Agencies
	Annual Condition	
	• Profile	Agencies/C-SHRP
	• Distress	Agencies
	• Strength	Agencies/C-SHRP
	• Friction	Agencies
	Environmental Data	C-SHRP
	Maintenance Monitoring	Agencies
	Data Management	C-SHRP
	Analysis	C-SHRP
	Reporting	C-SHRP
	Project Mangement	C-SHRP



SITE REQUIREMENTS

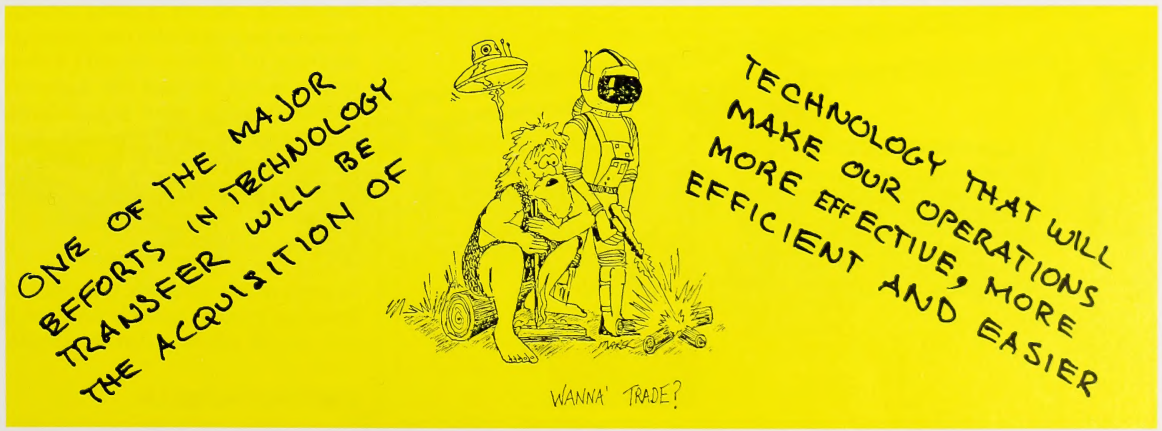
- Good visibility
- Absence of intersection and culvert
- Homogeneous soil type and condition

RUSSIAN DELEGATION VISITS DEPARTMENT

Comrades B. Kolesnikov and V. Strelnikova, General Director and Deputy General Director of Dortechnika from the state of Kazakh in the USSR visited the department and met with some senior officials.

Dortechnika is a state owned research institute and the delegation was interested in research exchange, predominantly in the pavements area. Research and Development Branch is coordinating further exchange of information.

Kazakh being a very large inland state extending over a large range of latitude has similar temperature extremes to us and hence similar pavement performance problems. Like ourselves they also have large tar sands deposits.


ONE OF THE MAJOR EFFORTS IN TECHNOLOGY TRANSFER WILL BE THE ACQUISITION OF
TECHNOLOGY THAT WILL MAKE OUR OPERATIONS MORE EFFECTIVE, MORE EFFICIENT AND EASIER
WANNA' TRADE?

RESEARCH AND DEVELOPMENT NEWS

Some recent changes have occured in the Research and Development Branch:

Safety and Equipment Section managed by **John Lowe** has been renamed **Roadway Engineering and Equipment Section**, to better reflect the kind of research undertaken as a result of evolving departmental needs.

Ray Filipiak has been appointed to manage the new **Technology Transfer Section** - good luck Ray, great things are expected from your section!

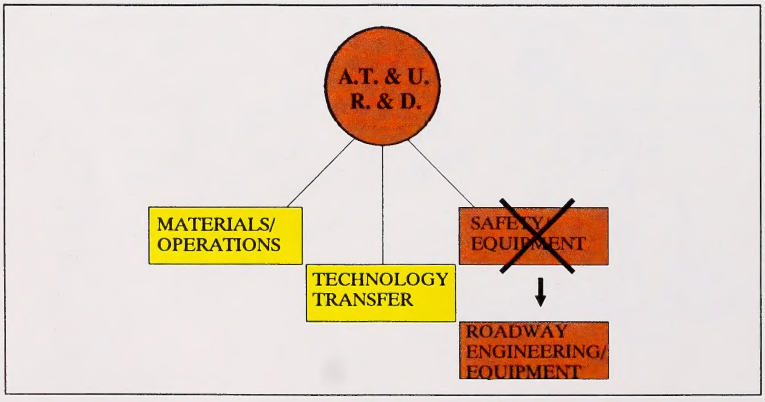
Roger Oberg's loss is our gain! **Brian Hunter** from District 8 has joined us on secondment, as a **Research Technologist** in the **Materials and Operations Section**. Hope you enjoy your stay with us Brian.

Allan Lo from Motor Transport Services has joined us as a **Research Engineer** in the **Roadway Engineering and Equipment Section**. Welcome aboard Allan, we have been trying to get you here for years!

Vern Kennedy liked it here so much on secondment, that he deserted Roadway Planning Branch and took up a permanent **Research Engineer** position with us - a wise decision Vern!

If you hear a new voice answering our telephones, it's because we have a new part time secretary, **Pamela Weber** joins us from the Electrical Protection Branch. You home handymen may have seen her smile when getting your electrical permits!

Zach Zacharia of Equipment Supply & Services Branch will be joining our branch on May 1, 1989 as the **Advanced Concepts & New Programs Engineer** in the **Technology Transfer Section**. Think of the service you'll get Ray Pasichnuk, now that you have one of your men in R & D.



RESEARCH IN REVIEW

Inherent in any research is the element of risk that an anticipated payback from a research activity does not get realized. However, through prudent selection of projects which suggest high pay-back potential and a good chance for success, we have had quite a few success stories, both big and small, over the past number of years. I'd like to mention just a few of these projects for two reasons. First, the scope and context of these activities may give readers an idea for new or follow-up projects which could benefit the department. Second, readers from other jurisdictions might pick up on some ideas for immediate application in their areas.

For those who may not be aware, Research and Development coordinates and performs research on several fronts. Internally conducted research employs our staff engineers and technologists to actually set up and carry out the research work plan, as well as to report the outcome. We've had a number of interesting successes here. We developed a temperature monitoring system for Equipment Branch paint machines that can permit an operator to monitor and adjust the temperature of road line paint as it is applied to the road surface to achieve best results (ABTR/RD/TM-87/11). For our Regional friends, we developed culvert thawing systems based on heating cables that permitted clearing of frozen culverts before spring runoff flooded the highways. These systems were significantly cheaper and easier to use than conventional techniques (ABTR/RD/TM-84/06 and TM-88/01).

In some of our research, our end user branches become actively involved in the work plan. For example,

(continued on page 11)

ALBERTA
BRIDGE INSPECTION & MAINTENANCE MANAGEMENT SYSTEM

Failures of bridge structures in other jurisdictions, pressures to permit heavier and larger vehicles on highways and the challenge to judiciously allocate the limited bridge funding have clearly demonstrated the need for a comprehensive bridge inspection and maintenance management system. Many jurisdictions have responded by developing computerized systems or upgrading their systems which, like those of Alberta, have evolved primarily to meet on-going maintenance requirements.

In 1985, Alberta undertook a review of bridge inspection practices. The review showed that regular inspections were completed province wide for all bridges on primary highways and major bridges on secondary and local roads. However, for other bridges on local and secondary roads, inspections under the jurisdiction of local road authorities were not consistent across the province. Also the inspection system which had evolved over the years could be strengthened with more formal documentation, with inspection manuals, and training courses for inspectors. Data from bridge inspections, which was stored on individual bridge files, used to determine overall maintenance requirements of the bridge system, was not easily accessible. A computerized system would greatly enhance the storage and retrieval of this data.

Recognizing this need the department decided to appoint a Bridge Inspection Manager and an eight member steering committee consisting of staff members with varied experience and background in bridge engineering. This committee was assembled to support the development of a comprehensive computerized Bridge Inspection and Maintenance Management System (BIM).

The primary objectives of the system were to ensure an appropriate level of safety to the travelling public, to protect the investment in

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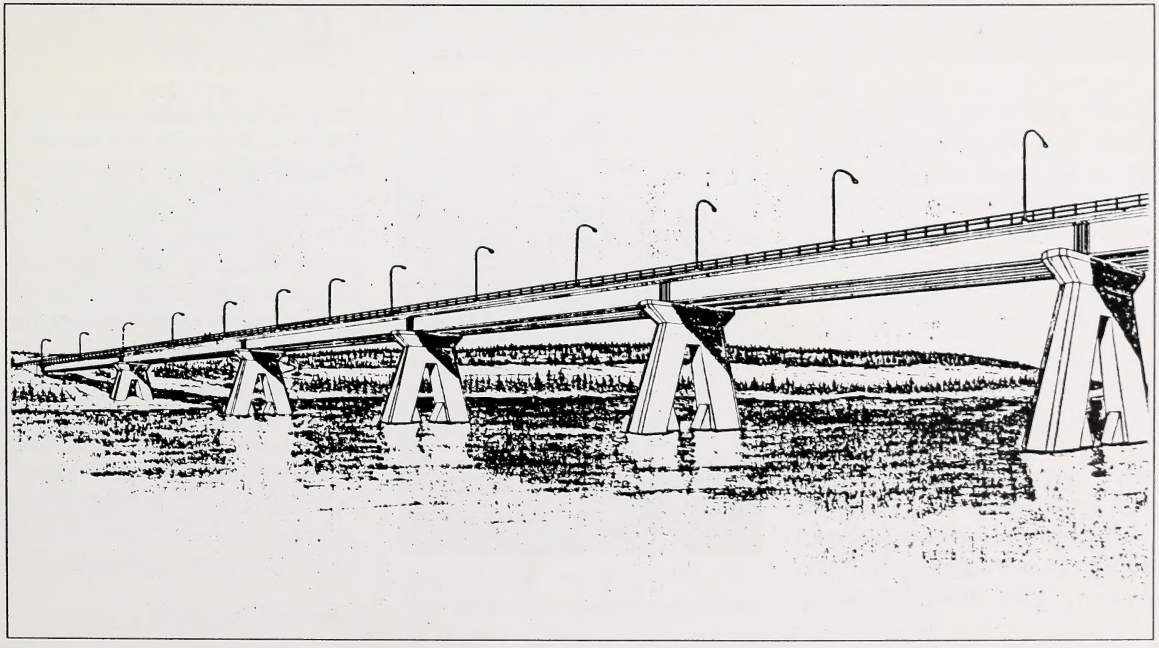


(BIM - continued from page 7)

bridge structures (estimated replacement cost for Alberta $1.4 billion), and to provide an improved management tool for bridge staff at all levels. In order to meet these objectives the system was to have the ability to store and process inventory, inspection and maintenance data for use in inspection management, maintenance programming, budget development, strategic planning and life cycle planning.

After reviewing the state of the art on the subject and analysing the existing systems in the department, it was concluded that a BIM System could be developed with all the desired capabilities in a very cost effective manner. Since 1970 the department has had a good bridge inventory system (BIS). Also a few years earlier a start had been made on developing computer generated inspection forms that were tailored to the type of bridge being inspected. Using these as starting points the development of the Bridge Inspection and Maintenance Management System began.

A paper entitled "Alberta Bridge Inspection and Maintenance Management System's", prepared by Jay Ramotar, P. Eng. and Reg Quinton, P. Eng., was recently presented at the 1988 RTAC Annual Conference. This paper describes the first phase of the system which includes layout of the system to accommodate present and future needs, details on the 27 different types of inspection forms, the condition rating procedure, sufficiency rating programs, and guidelines that govern the use of the system.

The BIM system is also supported by two manuals. The first manual is called the "BIM User Guide" and provides the user with operational procedures and details on the various options available in the system. The second manual called the "Inspection Manual" is a training and reference guide which was written specifically for the bridge inspector.

Further information regarding the BIM System may be obtained from Ernie Waschuk, Bridge Inspection Manager, or Reg Quinton, Manager - Bridge Services (A.T. & U., Bridge Engineering Branch) at (403) 427-6911.

BRIDGE ENGINEERING BRANCH

MINI TEXTURE METER

It isn't a fertilizer spreader or a fancy lawn weed remover and we aren't offering a free weekend in the mountains for a whole house carpet cleaning job, either. The device shown is a Mini-Texture Meter, manufactured by WDM Ltd., Bristol, England and is used for measurement of the texture of new rolled asphalt surfaces.

Pavement texture is the degree of irregularity in the pavement surface, or the depth of hollows below the average depth of the peaks. The texture of a pavement surface is what governs the skid resistance of

the pavement as well as the amount of road noise that will be generated when you drive your vehicle over it. Texture is broadly grouped into various categories (i.e. microtexture, macrotexture, roughness) depending on the scale at which the road is being viewed. For instance, at the large scale, roughness measurement gives a description of the longitudinal road profile and what is felt by the travelling motorist. At the other end of the spectrum, microtexture refers to the characteristics of single pieces of aggregate. The

(continued on page 9)

REMOTE DATA COLLECTION

In order to evaluate new products and techniques applied to the highway system or to judge existing performance, data is required. This often times necessiates site inspections by an Engineer or Technologist who makes a subjective evaluation based on his observations. Depending on the location of the test site and the frequency of the inspections this evaluation method can be very time consuming and expensive while providing little in the way of "cold hard facts" to support conclusions.

In an effort to improve this evaluation process Alberta Transportation and Utilities have installed automatic dataloggers at appropriate test sites. The dataloggers in use are programmable, multichannel analog to digital converters, with RAM storage and communications capabilities. Various sensors are avaliable which enable the devices to log such variables as temperature, soil moisture, wind speed, and a wide range of other measurable parameters.

An instance in which a datalogger proved its worth was in the evaluation of a Solar Powered Culvert Thawing System (ABTR/RD/TM-85/06). The system consisted of several solar heat collectors and a thaw pipe through which an antifreeze solution was circulated by a solar driven pump. The system was located in a remote area where frequent site inspections would have been inconvenient. By using a datalogger, daily measurments of sunlight intensity, antifreeze temperatures in and out of the heat collectors, air temperature, and flow rate were recorded. Using this recorded data and a spreadsheet program detailed analysis of the systems performance was possible resulting in a percentage efficiency rating and detailed graphs to support conclusions.

(continued on page 10)

(MINI TEXTURE METER continued from page 8)

Mini-Texture Meter measures macrotexture, or the surface characteristics that can be seen from a closeup view of the surface with the naked eye.

The most common measure of texture depth is the sand patch test, whereby a known volume of sand is used to fill an area of the pavement surface. Once the surface is filled to the top of the aggregate particles, the area covered is an inverse measure of the texture depth. The sand patch test is very laborious and only spot areas can be tested. The MTM speeds up the process of texture depth measurement substantially, using a non-contact laser projector and diode pickup device. The projected laser pulses are collected by a receiving lens and focused on a diode array. As the surface displacement changes, the pulse is focused on a different point on the array. The number of the diode where the beam pulse was focused is recorded in the meter and used for calculations.

The output of the meter is a paper tape roll indicating distance and the corresponding sensor measured texture depth. This value is the average surface texture measured over consecutive 10 m lengths. It is also averaged over 5 consecutive 10 m segments to give a 50 m spacing average. Other outputs are also possible for calibration and sensor checking purposes. Two measuring options are provided - one for newly laid rolled asphalt and one for other surfaces.

On new surfaces, the meter is used to measure the surface as soon as possible after rolling. The surface must be dry and clean (free from dust, dirt, loose chippings etc.). If the surface is still sticky, care is required during operation so as not to pick up material on the tires of the meter. The actual operation of the device is very simple - the meter is simply pushed over the area to be tested at normal walking speed (3 - 10 km/hr). This provides an immediate readout for control of the surfacing and rolling operation. The meter can also be used for spot measurement on existing pavements.

Good correlation between the sensor measured texture depth and the sand patch test on new rolled asphalt surfaces has been verified in Britain. The device is used widely in Britain by both contractors and government alike and pavement construction specs require that new pavement must conform to specific MTM measured values.

The research project in Alberta over the summer will involve putting the meter to use in a field situation to establish correlation between the meter output and field conditions. The evaluation will also include whether the meter would be suitable for province-wide use.

VERN KENNEDY

C-SHRP UPDATE

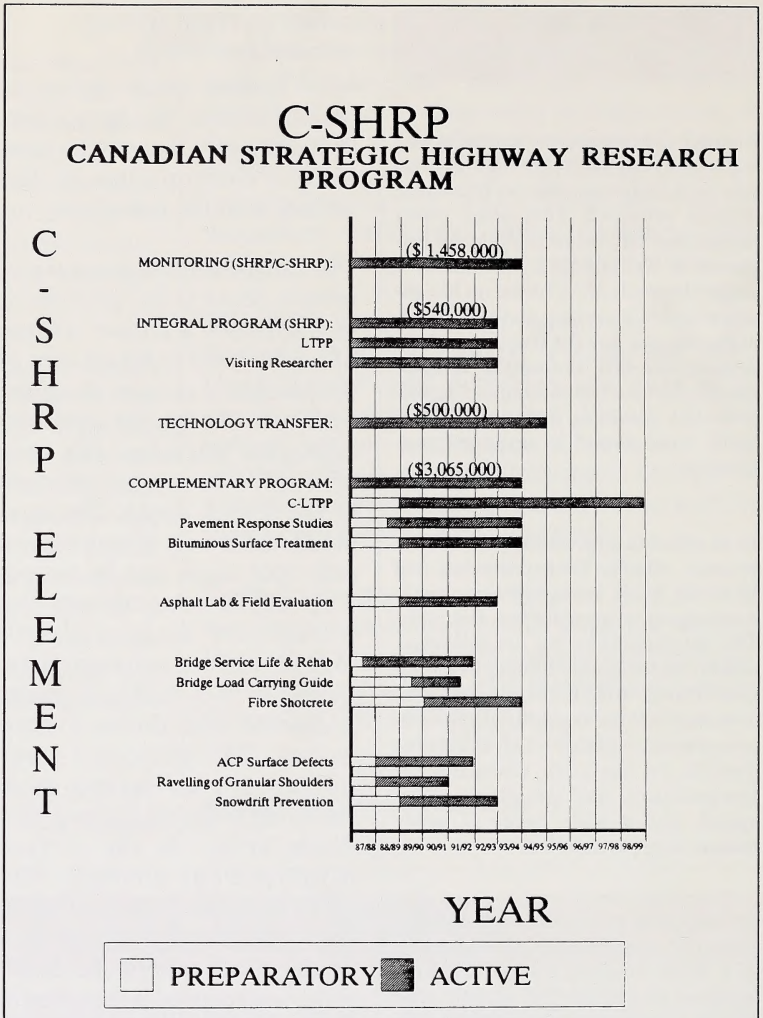
At their February 14, 1989, meeting in Toronto, the Council of Deputy Ministers of Transportation approved the extension of C-SHRP from the original five years to seven years, and also approved in principle a ten year monitoring period for the Canadian Long Term Pavement Performance (CLTPP) program.

These were very significant decisions for C-SHRP and the way has now been paved to maximise the benefits for the total C-SHRP program.

One of the main objectives of C-SHRP has been, and still is, to ensure that the complementary program of C-SHRP is truly complementary, ie. does not duplicate research being done in SHRP (except by design, to extend SHRP research to Canadian conditions or provide hands on experience to agencies) and addresses uniquely Canadian needs of national interest. As a result, by necessity, C-SHRP has had to lag SHRP in certain areas. SHRP funding was delayed by the U.S. Congress at the inception of that program and consequently SHRP has already been extended to a six year program.

In our C-SHRP complementary program, research in asphalts and long term pavement performance could not be launched until SHRP research in those areas was defined. This happened over the winter months and now our research direction in the corresponding areas has crystalized, and we are ready to go! The revised C-SHRP program is depicted in the table above.

JAN KONARZEWSKI



(DATA LOGGING DEVICES continued from page 9)

With the advent of relatively low cost self- contained dataloggers, research engineers have a powerfull new tool to assist them in evaluations. These versatile devices remain onsite 24 hours a day, require little maintenance and never stop for a coffee break (the perfect worker?).

DANNY O'BRIEN

(RESEARCH REVIEW
continued from page 6)

Operations Branch staff successfully tested a thermo electric generator for operating flashing lights at remote sites where bringing in conventional power would have been far more expensive (ABTR/RD/TM-87/02). While I'm at it, Grande Prairie should take a bow for their work on assessing the effectiveness of the "Sandvik" grader blade system for ice blading and surface dressing gravel roads. These tools (like giant teeth) proved very effective (ABTR/RD/RR-87/09).

External research, conducted on our behalf, by both private and university contracts have also been successful. One of the more notable projects done for the Roadway Engineering and Equipment side of Research and Development was performed by Dr. John Morrall of the University of Calgary. Dr. Morrall's efforts in the field of two lane roadway capacity and level of service are becoming world renowned.. His report entitled, "Two Lane Highway Level of Service and Simulation", (ABTR/RD/RR-87/10), was well received by departmental staff at an Edmonton presentation. The report summarized his work on calibrating and validating the Australian traffic simulation model, TRARR (Traffic on Rural Roads), to Alberta conditions, for application by our highway planners.

I could go on but I'm getting writer's cramp. Let me wind up by saying that reports for all these projects are available in the departmental library or through myself, as are reports for all the other projects conducted by Research and Development. I think it also appropriate to thank all those who have given the Research and Development Branch their support in the past and I look forward to working with all of you again on future projects.

JOHN LOWE

IS THERE AN EXPERT IN THE HOUSE ?

There still seems to exist out there a pervasive fear that computers and automation will spell out the end of the need for the human worker. On the contrary. If there ever was a need for the human factor it is now. Even more so now, as the complexities and intricasies of advancing technology give the mere mortal almost super human intelligence at the tip of his/her fingertips.

The Expert System (E.S.), an offshoot of the artificial intelligence (A.I.) field in computing which also includes things like robotics, computer vision, computer voice recognition and synthesis, is the next generation of the advancing computer age which is pounding on the doors of our industry. Countless applications in our highway industry exist and are awaiting adaptation of E.S. in order to make the tasks in our jobs easier and more efficient. The fact that many of the department's inhouse experts are retiring and taking with them their valuable knowledge (much of which is heuristic in nature acquired over the many years of hands on experience) and that this knowledge has never really been formally documented (because there has never really been an effective method for doing so) underlines the crucial need for considering the use of expert systems in many of our organizations operations.

Now, with all of that fancy introduction out of the way what is left is the bottom line question of - **what is an expert system and what can it do?** An expert system is a knowledge-intensive computer based program that solves problems which normally require human expertise. It performs many secondary functions, as an expert does, such as asking relevant questions and explaining its reasoning. Some characteristics common to expert systems include the following:

- They can solve very difficult problems as well as or better than human experts;
- They reason heuristically, using what experts consider to be effective rules of thumb, and they interact with humans in appropriate ways, including natural language;
- They manipulate and reason about symbolic descriptions;
- They can function with data which contain errors, using uncertainty judgemental rules;
- They can contemplate multiple, competing hypotheses simultaneously;
- They can explain why they are asking a question;
- They can justify their conclusion.

In rounding out the definition of what an expert system is and does the following should also be understood by the future user of an expert system:

- The "Knowledge Base" is the information source used by the expert system in the formulation of decisions which lead to a solution;
- The knowledge base may have a single or multiple source from which knowledge is extracted;
- The "Knowledge" can be emperical/algorithmic (ie. theory based formulas, specifications, etc.) or heuristic (ie. intuative rules of thumb based on historical human experience like that acquired by an expert over a period of time).

Research and Development, under the direction of the Technology Transfer section, is initiating a research project in expert system application. We hope to find an application that will address the current problem of heuristic expertise loss within the department. Also, to get as big-a-bang for our buck as possible, we would like to integrate the prototype application with an existing electronic data processing sytem (ie. Created by LOTUS,

(continued on page 12)

(EXPERT continued from page 11)

dBASE, Intergraph, or systems such as ICES, PMS, BIM or other) to support the fact that integration is indeed possible with any computer language based program(s) and that total abandonment of existing systems is not necessary. Most importantly, it is an absolute must that the following be considered:

- That there exist the ability to validate the results obtained through successful trial runs via the expert system in direct comparison to results obtained via current methods so that we can provide undeniable tangible proof of the benefits of an expert system; and

- That there be active support by the branch/section/area, region and/or district involved in the development of the expert system application in terms of manpower and training of future users and active participation in the heuristic human expert knowledge extraction process during the devlopment of the knowledge base.

Needless to say, I personally feel this is a very exiting technological area and I strongly feel that the benefits that the department will reap from this research effort will be numerous and far reaching. A preliminary survey reveals that very few departments of transportation have investigated the potential use of expert systems - in Canada, the Ontario Minestry of Transportation is the only DOT that has initied some work in this field. Caltrans (the California Department of Transportation) is about the only department of transportation that has a mandate for integrating knowledge based expert systems into their operations. Yet, the majority of the Fortune 500 companies in North America have successfully, and profitably, integrated expert systems into many aspects of their organizations operations.

This year A.T. & U. is going to take it's first small step into practical expert sytem application so that, hopefully, it will become one large technological leap into the future for our department as a whole.

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